

Counting California's Snakebites

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■ *Poisonous snakebites happen in all sections of California, but they are especially frequent in Southern California. An estimated 221 (138 in-patients and 83 out-patients) people were bitten by snakes annually, an incidence of 1.41 bites per 100,000 people. However, the estimated case-fatality rate was less than one-half of one per cent.*

Of 135 in-patients reported in detail by California hospitals during 1958 and 1959, 123 (91 per cent) were bitten by rattlesnakes, one (1 per cent) by a foreign snake, and 11 (8 per cent) by unidentified poisonous snakes. "Seasonal epidemics" of snakebites occurred, 90 per cent of the bites being inflicted from April through October.

Males had higher bite rates than females and Caucasians had higher rates than non-whites. Fifty per cent of the cases were among children and young adults less than 20 years of age. Ninety-nine per cent of the bites were on the extremities—65 per cent on the upper extremities and 34 per cent on the lower extremities. The recommended treatment of poisonous snakebites included incision and suction and the 3 A's (antivenin, antibiotics and anti-tetanus treatment).

CALIFORNIA has an abundance of poisonous snakes—rattlesnakes. Russell^{8,9} collected information about poisonous snakebites in 11 counties of Southern California and estimated that at least 60 to 70 bites happened there each year. Furthermore, 12 persons in California died of poisonous

snakebites during the ten-year period 1950-1959.³ Since snakebites seemed to be an important medical problem in California and since no reliable count of the incidence of snakebites for the entire State was available, a survey of snakebite accidents was planned. The purposes of this study were: (1) to describe epidemiologic aspects of poisonous snakebites for the entire State of California; (2) to relate some medical findings associated with these bites; and (3) to review briefly current concepts of snakebite treatment.

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Poisonous Snakes

Ten species or sub-species of poisonous snakes are indigenous to California. All are rattlesnakes. According to Klauber,¹ the rattlesnakes found in California include: the western diamond (*Crotalus atrox*), the Mojave Desert sidewinder (*Crotalus cerastes cerastes*), the Colorado Desert sidewinder (*C. cerastes laterorepens*), the south-western speckled (*C. mitchelli pyrrhus*) and the Panamint (*C. mitchelli stephensi*). Also, the red diamond rattlesnake (*C. ruber ruber*), the Mojave (*C. scutulatus scutulatus*), the Southern Pacific (*C. viridis helleri*), the Great Basin (*C. viridis lutosus*), and the Northern Pacific (*C. viridis oregonus*). Coral snakes are not native to California but are found in Arizona and Mexico.

Rattlesnakes are pit vipers (as are copperheads and cottonmouth moccasins). They are so named because of a characteristic pit which is located between the eye and nostril on each side of the body. Pit vipers also are identified by elliptical pupils in the eyes and by two well-developed fangs which protrude from the maxillae when the snake's mouth is opened. Rattlesnakes have rattles which are attached to their tails. Harmless snakes do not have facial pits, they have round rather than elliptical pupils, and while they have teeth they do not have fangs.

Oftentimes people will chop off the head of a snake which has bitten someone and bring the snake's body in for identification. Without the head pit vipers can be identified by turning the snake's belly upward and noting a single row of subcaudal plates just below the anal plate. Harmless snakes have a double row of subcaudal plates. Figure 1 depicts the characteristic features of pit vipers and harmless snakes.

Methods of Study

A questionnaire and letter explaining the purpose of this study were mailed to a "selected" group of California hospitals listed in the Hospitals Guide Issue of the Journal of the American Hospital Association. The hospitals selected for this study were general hospitals, children's hospitals and college infirmaries. Questionnaires were also sent to Army, Navy, Coast Guard, Public Health Service, Air Force and Veterans Administration hospitals. Maternity, tuberculosis and mental hospitals were omitted, as they would not be expected to treat snakebite victims. A total of 356 California hospitals made up the study group. Each hospital was asked to report all in-patients admitted to the hospital for snakebite treatment during 1958 and 1959.

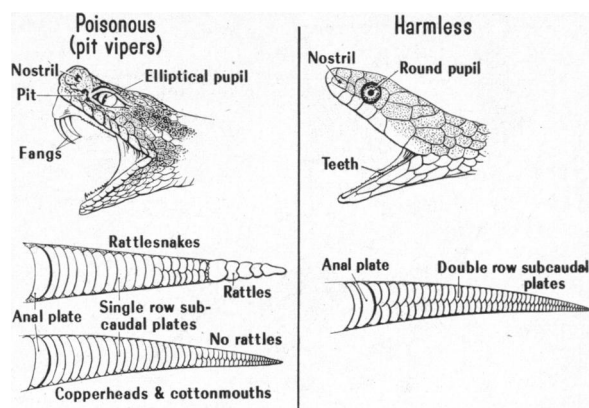


Figure 1.—Characteristic features of poisonous (pit vipers) and harmless snakes.

Most hospitals do not code and tabulate the diagnoses of emergency room and out-patient clinic visits. Since some snakebite victims are not admitted to the hospital as in-patients, it seemed essential to ask a sample of practicing physicians how many snakebite victims they treated both as out-patients (office, home, emergency room, etc.) and as in-patients. Previous surveys^{4,7} have shown that most people with venomous snakebites are treated by general practitioners, surgeons, internists, pediatricians and orthopedic surgeons. Therefore questionnaires were sent to a random sample of one-third of all the California physicians in these categories of practice who were listed in the AMA American Medical Directory.

Death certificates in fatal snakebite cases were obtained from the California State Department of Public Health.

Results

This report is based on questionnaires returned by 349 (98 per cent) of 356 California hospitals. It is supplemented by questionnaires returned by 2,495 (74 per cent) of 3,387 practicing physicians in the state. The California State Department of Public Health indicated that there was one snakebite death in 1959 and none in 1958.

Incidence

California hospitals reported a total of 146 in-patients treated for poisonous snakebites during 1958 and 1959. There were 68 cases in 1958 and 78 in 1959, an average of 73 cases per year. Detailed case reports were received for 135 of the 146 snakebite cases reported during 1958 and 1959. All the analyses in this paper, excluding the estimate of incidence, were based on the 135 detailed case reports received from hospitals.

Physicians' reports, when adjusted to account for all California physicians in the practice cate-

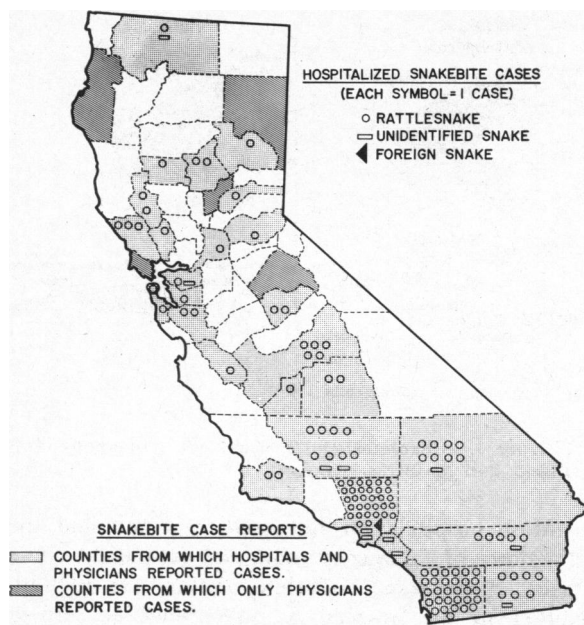


Figure 2.—Geographical distribution of poisonous snakebites in California, 1958 and 1959.

gories mentioned, indicated that approximately 138 in-patients and 83 out-patients were treated for snakebite accidents each year. This estimate takes into account the elimination of duplicate reports by hospitals and physicians. The difference between the estimate of 138 in-patients treated by physicians and the average of 73 in-patients reported by hospitals can be explained, in part, by the following facts: (1) seven California hospitals did not participate in the study; (2) there was evidence of under reporting snakebite in-patients from 15 hospitals which participated in the study; and (3) physicians indicated that many patients were treated in small clinics and hospitals not listed in the AHA Hospitals Guide Issue. Taking all of these various reports into consideration, we estimate that approximately 221 (138 in-patients and 83 out-patients) persons are treated annually for poisonous snakebites in California—an annual incidence of 1.41 bites per 100,000 population.

Geopathology

The geographical distribution of snakebites reported in California during 1958 and 1959 may be seen in Figure 2. The lightly shaded counties are those from which hospitals reported in-patients treated for snakebites. An appropriate symbol is used to show where each hospital patient was treated and what kind of snake bit him. The darker shaded counties are those from which physicians reported snakebite cases but from which no cases were reported by hospitals.

Of 135 persons put in hospital for snakebite

treatment and for whom detailed records were available, 123 (91 per cent) were bitten by rattlesnakes, one (1 per cent) by a foreign snake, and 11 (8 per cent) by unidentified poisonous snakes. Of the bites inflicted by rattlesnakes, the following species were incriminated: Northern Pacific, 12 bites; Southern Pacific, ten bites; western diamond, seven bites; sidewinders, seven bites; red diamond, four bites; and Mojave, three bites. By comparing the geographic location of the case reports with the ecological distribution of snakes described by Klauber,¹ apparently the Panamint and the Great Basin rattlesnakes do not bite many people in California. One victim was bitten by an Australian tiger snake (*Notechis scutatus*) in Los Angeles. He was critically ill but survived after heroic treatment.

Figure 2 shows that poisonous snakebites occurred in all sections of California but were most frequent in Southern California, less frequent in Central California and least frequent in Northern California. Most bites (76 per cent) were reported from the ten southernmost counties in the state.

Temporal Relationships

The monthly distribution of snakebite accidents is shown in Table 1. Snakebites were infrequent during the colder months of the year—November, December, January, February and March. In general, snakes are usually hibernating or are inactive during the colder months. Most snakebites in California occurred from April through October when 121 (90 per cent) of the 135 bites were inflicted. This striking seasonal distribution of bites coincides with the time that snakes are most abundant and active and with the time that people have greater exposure due to out-of-doors occupations and recreation. Similar “seasonal epidemics” of venomous snakebites have been observed in New England, and Florida.^{4,7}

The time of day when most snakebite accidents happened was the three-hour period from 3:00-5:59 p.m. when 37 (27 per cent) persons were bitten. The number of bites, by three-hour periods, were: 6:00-8:59 a.m., ten bites; 9:00-11:59 a.m., 22 bites; 12:00 noon-2:59 p.m., 27 bites; 3:00-5:59 p.m., 37 bites; 6:00-8:59 p.m., 24 bites; and 9:00-11:59 p.m., 8 bites. There were no bites from 12:00 midnight to 5:59 a.m. For seven cases the time of the bite was not recorded.

Bite Victims

There were 108 white males, 24 white females, two non-white males and one non-white female admitted to California hospitals for snakebite treatment during 1958 and 1959. Of the non-whites, two were Indians and one was a Negro. Using the 1960 census for the population of Cali-

fornia the bite rates per 100,000 population were: 1.50 for white males, 0.31 for non-white males, 0.33 for white females and 0.16 for non-white females.

The age distribution of California bite victims is shown in Table 2. The largest number of bites happened to children and youths 10 to 19 years of age (37 bites) and those 0 to 9 years of age (31 bites). Indeed 50 per cent of all snakebites were inflicted on children and young adults less than 20 years of age. Age-specific bite rates are much more meaningful since they take into account the population at risk in a particular age group. The highest biannual bite rates per 100,000 population were: 10 to 19 years of age (1.47) and 20 to 29 years of age (1.30). The lowest bite rate was found for people 50 to 59 years of age.

An analysis of the occupations of the patients showed that 68 were children, 15 were laborers other than farm laborers, ten were farmers or farm laborers, seven were professionals, five were housewives and four were craftsmen. In addition, 11 were members of the Armed Services, three were unemployed, two were managers and one was a clerk. The occupation was not stated for the remaining bite victims.

Activity and Place

Twenty-three bites occurred while people were handling a poisonous snake. Eighteen happened while children were playing, ten in their own yards and eight elsewhere. Ten persons were bitten while working on a farm or ranch, six while hunting or fishing, six while picking up lumber or a log, five while working in their own yards, and five while on Army or Navy field exercises. Three people were bitten while walking on or near a highway, three while reaching into an obscure place, and three while working or playing about a barn or hen-house. For the remaining patients the activity was not stated.

The place where the bite accident happened is closely related to what the patient was doing when bitten. The largest number of snakebites, 15, happened right in the patients' own yards. Eleven people were bitten in a field away from the house, ten on a farm or ranch not near the house, ten in the woods, eight in or under a building, eight near a lake, river or body of water, five in a field near the house, three in a barn or hen house and three on or near a highway. The place the bite accident happened was not coded for the other patients.

Site and Severity

The anatomical sites on human beings where venomous snakes inflicted their bites are shown in Table 3. Ninety-nine per cent of the bites were

TABLE 1.—Seasonal Distribution of Poisonous Snakebites in California, 1958 and 1959

Month	Number of Bites	Month	Number of Bites
January	2	July	20
February	2	August	21
March	5	September	16
April	19	October	6
May	23	November	4
June	16	December	1

TABLE 2.—Age Distribution of Snakebite Victims Treated in Hospital in California, 1958 and 1959

Age Group (years)	Population at Risk*	Number of Bites	Rate per 100,000†
0-9	3,345,951	31	0.93
10-19	2,513,766	37	1.47
20-29	1,999,743	26	1.30
30-39	2,319,498	23	0.99
40-49	2,044,658	7	0.34
50-59	1,528,192	4	0.26
60-69	1,101,743	4	0.36
70 or more	863,653	3	0.35

*Based on the 1960 Census of the Population of California.

†These rates are only on hospitalized patients for whom information was available.

TABLE 3.—Anatomical Sites of Bites By Poisonous Snakes in California, 1958 and 1959

Anatomical Site of Bite	Side of Body Right	Side of Body Left	Total Number of Bites
Head, face and neck	0	0	0
Trunk, front	0	0	0
Trunk, back	0	0	0
Upper arm	3	0	3
Forearm	4	5	9
Hand	10	11	21
Fingers	27	28	55
Upper leg	1	3	4
Lower leg and ankle	18	10	28
Foot	4	6	10
Toes	2	2	4
Not stated	1

inflicted on the extremities—65 per cent on the upper and 34 per cent on the lower. On the upper extremities the fingers and hands were the parts most often bitten. The feet and lower legs, including the ankles, were the most common sites on the lower extremities. In one case the site was not recorded.

A modification of the clinical classification of pit vipers venenation by Wood, Hoback and Green¹⁰ was used to determine the severity of bites. Bites were classified as follows:

GRADE 0—*No venenation*. Fang or tooth marks, minimal pain, less than one inch of surrounding edema and erythema. No systemic involvement.

GRADE I—*Minimal venenation*. Fang or tooth marks, severe pain, 1 to 5 inches of surrounding edema and erythema in first 12 hours after bite. No systemic involvement usually present.

GRADE II—*Moderate venenation.* Fang or tooth marks, severe pain, 6 to 12 inches of surrounding edema and erythema in first 12 hours after bite, systemic involvement may be present—nausea, vomiting, giddiness, shock or neurotoxic symptoms.

GRADE III—*Severe venenation.* Fang or tooth marks, severe pain, more than 12 inches of surrounding edema and erythema in first 12 hours after bite, systemic involvement usually present as in Grade II.

The severity of venenation (venom poisoning) was classified as follows for 128 patients treated in hospital: 42 (33 per cent) were Grade 0; 29 (23 per cent) were Grade I; 27 (21 per cent) were Grade II; and 30 (23 per cent) were Grade III. For the remaining seven patients treated in hospital the severity or venenation was not stated. There was one death among the 135 hospital patients in this series, a case-fatality rate of 0.7 per cent. When the total number of snakebite cases per year is taken into account (in-patients plus out-patients), the true case-fatality rate probably is less than 0.5 per cent. This is confirmed by the fact that only 12 people in California died of snakebite from 1950 to 1959.³ The fatal snakebite in 1959 involved a four year old boy who was bitten on the foot by a rattlesnake when he stepped into a hole in his yard. He died 16 hours later. Contrary to popular belief, few patients die within the first few hours following a snakebite. About 70 per cent of them die from 6 to 48 hours after venenation takes place.⁵ According to Russell^{8,9} deaths from rattlesnake bites in Southern California have been attributed to intraperitoneal or retroperitoneal hemorrhage associated with hemolytic anemia, to acute pulmonary edema associated with respiratory failure, or to vascular collapse associated with acute hemolysis. He also noted that vascular collapse may occur through direct action of the venom on the heart. The two papers by Russell^{8,9} are highly recommended for readers who are interested in the toxicologic features of rattlesnake venoms and the signs and symptoms of rattlesnake venom poisoning.

Treatment

The current treatment of North American pit viper (rattlesnake, cottonmouth moccasin and copperhead) bites includes both minor surgical procedures and conservative forms of treatment. A constricting band (tourniquet) should be applied lightly to the involved extremity several inches proximal to the bite. The constricting band should be applied only tight enough to occlude the superficial venous and lymphatic flow. It must not occlude the arterial circulation and it should be

released every 10 to 15 minutes for a minute or two. As edema resulting from venom poisoning spreads, the constricting band should be advanced to keep just ahead of the swelling. The purpose of the constricting band is to impede the spread of venom until incision and suction can be used to remove the venom mechanically and/or until antivenin can be administered to neutralize the venom.

Incision and suction is effective in removing venom from experimental animals up to about 120 minutes after the venom is injected. The sooner it is used, the larger the amount of venom that can be removed. Suction should be used for about one hour. We have found the suction cups supplied in the Cutter and the Becton-Dickinson snakebite first-aid kits effective for removing pit viper venom. Incisions one-quarter inch long and one-eighth to one-quarter inch deep are made into the subcutaneous tissues over the fang punctures. A few additional incisions (three to five) may be made in the surrounding edematous tissues. A large number of incisions is not needed. Immobilization aids in limiting the spread of venom. However, if one must decide between immobilization or seeking prompt medical treatment, the latter should be sought.

The "3 A's" (antivenin, antibiotics, and tetanus antitoxin and/or toxoid) are recommended, in addition to incision and suction, in treating all serious pit viper bites. Antivenin Crotalidae Polyvalent (Wyeth) is effective in neutralizing the venoms of all North American pit vipers. It is not protective against coral snake venom. Since antivenin is manufactured from horse serum, a skin test should be done before antivenin is given. For Grade I venenations, antivenin may be administered in the deltoid or gluteus muscles. In Grade II and Grade III venenations, antivenin diluted in 1000 ml of normal saline solution may be given intravenously.⁶ Studies with radioisotopes have shown that antivenin accumulates at the site of the bite more rapidly after intravenous administration than after intramuscular administration.² Injection of antivenin into the local bite area is not a particularly effective way to administer antivenin. We have found the following amounts of antivenin useful in treating the various Grades of venenation: Grade 0 (no venenation) requires no antivenin; Grade I (minimal venenation) may require 10 ml (one ampoule) of antivenin; Grade II (moderate venenation) requires 30 to 40 ml of antivenin; and Grade III (severe venenation) requires 50 ml or more of antivenin.

Since snakes' mouths and venoms may harbor pathogenic organisms, antibiotics and tetanus anti-

toxin and/or toxoid should be given prophylactically. Gram-negative organisms predominate, hence a broad-spectrum antibiotic is indicated. Penicillin used by itself is not adequate treatment.

Cortisone and ACTH do not affect the survival rate of animals poisoned with pit viper venom. They probably should not be used during the first few days after venenation, although they may be beneficial later in treating serum sickness resulting from antivenin therapy. Antihistamines are contraindicated, as they shorten the survival time of animals poisoned with pit viper venoms. Shock resulting from venom poisoning should be treated with infusions of blood, plasma, saline solution and vasopressor drugs. Meperidine hydrochloride and other analgesics may be given to relieve pain. Recently there have been reports of excessive tissue necrosis and amputations associated with cold therapy such as packing an extremity in ice or using ethyl chloride.² In our opinion, cold therapy should not be used in treating pit viper bites.

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CORRECTION

On Page 243 of the October 1963 issue of CALIFORNIA MEDICINE two charts were transposed. The chart above the legend for Chart 2 is Chart 3; that above the legend for Chart 3 is Chart 2.